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02/28/96



LONGVIEW FIBRE COMPANY

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P.O. BOX 24867
SEATTLE, WASHINGTON 98124
206-762-7170 FAX 206-767-2442

February 28, 1996

Fred Austin
Puget Sound Air Pollution Control Agency
110 Union Street, Suite 500
Seattle, WA 98101-2038

RECEIVED

MAR - 1 1996

PUGET SOUND AIR POLLUTION
CONTROL AGENCY

Dear Mr. Austin:

This is our source test plan for emissions on our new boiler. We would like to start the test on March 20, 1996. We request your approval. Please notify me if this will be possible.

If you have any questions, please call me at 762-7170.

Thank You,

Sonny L. Bivins

Sonny L. Bivins
Maintenance General Foreman
Longview Fibre Company, Seattle, WA

SLB:ka



LONGVIEW FIBRE COMPANY
Seattle, WA

Source Test Plan

AIREMISSIONS TEST
CLEAVER-BROOKS BOILER
(20 MMBtu/hr)
NOC-6264

PURPOSE:

The purpose of this test is to quantify the stack gas outlet opacity and concentration and emission rate of Particulate Matter with a diameter of less than ten microns (PM - 10), Oxygen (O₂), Carbon Dioxide (CO₂), Sulfur Dioxide (SO₂), Oxides of Nitrogen (NO_x), Carbon Monoxide (CO) and Volatile Organic Compounds (VOC) from the Natural Gas Fired Cleaver-Brooks Boiler rated at twenty five point one Million British Thermal Units (20 MMBtu) of heat input located at the Longview Fibre Company facility on East Marginal Way South in Seattle, Washington.

PM-10 test results will be presented in concentration units of grains per dry standard cubic feet corrected to seven percent oxygen (grains/dscf @7% O₂) for comparison to the Applicable Standard (AS) listed in PSAPCA NOC# 6264. Diluent O₂ and CO₂ test results will be presented in units of percent by volume (%/v). Pollutant SO₂, NO_x, CO and VOC test results will be presented in concentration units of parts per million by volume (ppm/v) and emission rate units of pounds per Million British Thermal Units (lbs/MMBtu) of heat input. VOCs will be measured as Propane (C₃H₈) and reported as Total Organic Carbon (TOC) less Methane (CH₄).

PROCEDURE:

Valid Results, Incorporated will perform the following Environmental Protection Agency (EPA) Title 40 Code of Federal Regulations Part 60 (40CFR60) Chapter I Appendix A Test Methods.

Method	Parameter	Analysis	Duration	Application
• 1	Sample Point Locations	tape measure	once	Inside Stack Diameter (D _{eq})
• 2	Volumetric Flow Rate	pressure-temp	3- 15 minute	Pitot, Manometer & Thermocouple
• 3A	Molecular Weight (O ₂ , CO ₂)	analyzer	3 one-hour	Paramagnetic-O ₂ / IR-CO ₂
• 4	Moisture Content	gravimetric	3 half-hour	Weight Gain - Sample Volume Ratio
• 5	Particulate Matter (PM-10)	gravimetric	3 one-hour	Front And Back Half Analysis
• 6C	Sulfur Dioxide (SO ₂)	analyzer	3 one-hour	UltraViolet Photometric (UV)
• 7E	Oxides of Nitrogen (NO _x)	analyzer	3 one-hour	Chemiluminescent (CHEM)
• 9	Visible Emissions	opacity	1 six-minute	WA DEQ Certified Observer
• 10	Carbon Monoxide (CO)	analyzer	3 one-hour	Non-Dispersive Infrared (NDIR)
• 25A	Hydrocarbons (TOC - CH ₄)	analyzer	3 one-hour	Flame Ionization Detection (FID)

Test Methods 1, 2, 3A and 4 will be performed in conjunction with the Method 5 PM-10 tests to determine the stack gas volumetric flow rate in dry standard cubic feet per minute (DSCF/M) for calculation of representative emission rates. Test Method 6C will be performed to determine the parts per million by volume (ppm/v) concentration of gaseous Sulfur Dioxide (SO₂) by ultraviolet photoluminescence (UV). Test Method 7E will be performed to determine the ppm/v concentration of gaseous Oxides of Nitrogen (NO_x) by Chemiluminescence. Test Method 10 will be performed to determine the ppm/v concentration of gaseous Carbon Monoxide (CO) by Non-Dispersive Infrared Detection (NDIR). Test Method 25A will be performed to determine the ppm/v concentration of gaseous Total Non-Methane Hydrocarbons (TOC - CH₄) by Flame Ionization Detection (FID).

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SOURCE TEST METHODS:

METHOD 1: Selection of Traverse Points

EPA Method 1 will be used to determine the location of sample points for the particulate and velocity traverses. The number of sample points used and their specific locations will be determined by the number of equivalent inside stack diameters that the sample ports are located from the nearest upstream and downstream flow disturbances.

METHOD 2: Stack Gas Velocity and Volumetric Flow Rate

EPA Method 2 will be used to determine the stack gas velocity and volumetric flow rate. Pressure and temperature readings will be taken at the sample points determined by Method 1. Pressure readings will be measured using a "S-type" Pitot tube and an inclined manometer connected through quarter inch tubing. Pitot tube leak checks will be performed before and after every test run. The stack gas temperature will be measured using a calibrated (+/- 1 degree Fahrenheit) type-K thermocouple attached to the Pitot tube to provide the sampling point temperature simultaneously with the velocity measurement.

During the velocity traverse a stack static pressure will be taken by turning the pitot perpendicular to the gas flow (zero delta P) and removing the appropriate side of the pitot from the manometer (+ or -).

The other data necessary for the calculation of the volumetric flow rate are the barometric pressure, moisture content of the effluent, and the stack gas composition (O₂ and CO₂).

METHOD 3A: Molecular Weight Determination

EPA Method 3A will be used to determine the percentage by volume of oxygen (O₂) and carbon dioxide (CO₂) in the effluent stream. These concentrations will be used to determine the dry and wet stack gas molecular weights. Method 3A (continuous emission analyzer - paramagnetic and infrared) will be used to correct the Method 5 PM-10 test results to seven percent oxygen.

A representative sample of the effluent gas will be extracted using a "rake" type stainless steel probe (described in Method 25) containing an in-stack quartz glass wool filter at the analyzer (closed) end of the probe tip. Calibration gas will be applied to front of the quartz glass wool filter. The sample will be dried by condensation near the sample ports and then drawn through a Teflon® sample line to the vacuum side of a Teflon head sample pump. After leaving the pressure side of the pump, the sample will be passed through a heated 5 µm filter and delivered to a sample manifold under constant pressure. As required, the sample will be delivered from the sample manifold to a paramagnetic oxygen and nondispersive infrared carbon dioxide analyzer. The analyzer output voltage will be recorded by a Data Acquisition System (DAS) and back-up strip chart recorder that will be operated continuously throughout the test.

A Sample/Calibration Gas Control Module will be used to direct and control the flow of sample and calibration gases to the analyzers. In addition to providing samples of the effluent gas to an analyzer, the Control Module permits direct (internal) calibration of the analyzers, or calibration of the analyzers through the sample system (external). The Control Module employs a by-pass valve to maintain a constant sample (or calibration gas) pressure at the sample manifold. Flow meters monitor bypass flows from the back-pressure regulator and sample ports on each analyzer. The probe-to-manifold sample line consists of 3/8-inch Teflon® tubing. 1/4-inch Teflon® tubing delivers sample to the analyzers from the sample manifold.

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METHOD 3A: Molecular Weight Determination (continued)

Leak checks of the sample system will be conducted before and after each test sequence. Leak checks will be performed by capping the sample probe in front of the filter and using the sample pump to draw a vacuum on the sample system. Sample system integrity will be verified by the total sample flow rate meter dropping to zero (except for the inherent sample pump oscillation).

The calibration of each analyzer (including the sample system) will be verified before and after each test run using EPA Protocol 1 gases. A selector valve at the Gas Control Module will direct the flow of different calibration gases to the front end of the sample probe or to the sample manifold as needed. At the probe, a pressure activated valve will be used to select either a gas sample from the sample probe or calibration gas supplied to the probe through a calibration gas line.

EPA Protocol 1 calibration gas blends will be utilized with Method 3A to perform low and high range external calibrations for both the O₂ and CO₂ analyzers. Oxides of nitrogen and carbon monoxide blended with nitrogen (NO₂/CO/N₂) will be used for the "zero" gas.

METHOD 4: Stack Gas Moisture Content Determination

EPA Method 4 will be used to determine the moisture content of the stack gas. A condenser assembly comprised of four glass impingers set in an ice bath will be used to extract and collect the moisture from the effluent gas sample. The first two impingers will contain 100 ml of deionized water. The third impinger will be tare weighed and left empty to collect any potential condensate carryover, and a fourth impinger will contain a previously weighed amount of silica gel to act as the "absolute" collector of residual condensate.

A known volume of effluent gas, as measured by a calibrated metering system connected to the extraction pump, will be passed through the heated probe to the condenser assembly for a specific period of time. Once the extraction is complete, the amount of liquid (condensate) in the impingers will be measured volumetrically or gravimetrically and the net gain determined. The total condensate gain of the condenser assembly will be determined and recorded along with the calculated "corrected" volume of gas that was directed through the system. The subsequent moisture content of the stack gas will then be determined from these collected variables.

METHOD 5: Particulate Matter Determination (PSAPCA)

EPA Method 5 will be used to determine the concentration and emission rate of front half particulate matter in the stack effluent. The Method 5 back half impinger catch will be analyzed for condensible and organic compounds (water, acetone and methylene chloride fractions). The total front and back half particulate matter will be assumed to be particulate matter less than ten microns in diameter (PM-10). The sampling will be performed utilizing a Nutech 2010 Isokinetic Stack Sampling System (glass nozzles, probe liners and filters).

Method 5 provides for a sample of stack gas to be extracted isokinetically through a quartz glass nozzle from points located within equal cross-sectional areas of the stack. The sample will be maintained in the vapor phase and drawn through a heated, quartz glass probe liner into a heated glass filter assembly containing a glass fiber filter. The sample will then be drawn through Teflon® tubing into a chilled condensing unit consisting of four glass impingers as described in the Method 4 description above. The condensing unit will effectively remove all moisture from the sample gas being collected before it enters the sample pump and dry gas volume measuring system.

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METHOD 5: Particulate Matter Determination (continued)

The sampling system will be leak-checked at the nozzle before every test run using 15 inches of vacuum, and after every test run at a vacuum equal to the highest vacuum reached during that test run. After the successful completion of each test sequence, the "Front half" (before the filter) particulate emissions will be collected by triple rinsing and brushing the probe liner and nozzle with acetone. The glass fiber filter holder and back-half impingers will then be sealed with aluminum foil for subsequent sample recovery following the test sequence.

PM-10 emissions will be calculated from the weight gain of Total (front and back half) Particulate Matter. The particulate matter weight gain will be determined utilizing procedures described below. Emission rates will be calculated using the equations provided in 40CFR60 Chapter I Appendix A Test Method 5.

Filters will be initially conditioned by desiccation for 24 hours. The filters will then be weighed repeatedly every six hours until a constant weight is achieved. A constant weight will be reached when the difference of three consecutive weights from the average does not deviate by more than ± 0.5 milligrams. Two filters "field blank and trip blank" will also be weighed for post-test analysis validation that the test samples have not been contaminated.

The post-test filters will be desiccated for at least 24 hours before being weighed. A filter "blank", which will be handled in the same manner as the filter samples, will also be conditioned and weighed. The net gain from the filter blank will be subtracted from the particulate gain of the total sample.

The front half of the filter holder will be triple rinsed and brushed with acetone into the "front-half" sample jar. The "front-half" washes will then be transferred to a desiccated and tare weighed aluminum dish. The weighing tins will then be evaporated to dryness, desiccated and weighed to a constant weight. A "reagent blank" sample will be retained from the acetone lot. The net gain from the reagent blank will also be subtracted from the particulate gain of the total sample if the blank residue is < 0.01 mg/g or 0.001% of the weight of the reagent used.

The "Back half" sample (water, acetone and methylene chloride) will be recovered by extracting the organic compounds from the impinger water with methylene chloride. This methylene chloride fraction will then be placed in a tare weighed glass beaker for evaporation at room temperature. The remaining impinger water will then be placed in an additional tare weighed glass beaker and evaporated to dryness at 150 degrees Fahrenheit. The impingers and separation funnel will then be triple rinsed with acetone and placed into a tare weighed aluminum dish for evaporation.

The "Back half" particulate emissions will be calculated using the weight gain from the impinger water, final acetone impinger rinse and methylene chloride organic extraction fractions.

METHOD 6C: Sulfur Dioxide Determination

EPA Method 6C will be used for the continuous measurement of SO₂ concentrations in the effluent gas utilizing an ultraviolet photometric analyzer.

The SO₂ analyzer will be calibrated using a nitrogen "zero Gas" and EPA Protocol 1 "equivalent" blends of Sulfur Dioxide/nitrogen (SO₂/N₂) to provide span concentrations of approximately 40 to 60%, and 80 to 100% of the SO₂ analyzers' full scale range. EPA Protocol 1 "equivalent" blends are defined in 40CFR60 Chapter 1 Appendix A Test Method 6C Section 6.1.2 Alternative #2 as certified standards that have been triple analyzed within six months of their use by Method 6 and shown to be within 5% of the certification value. All zero and span checks will be recorded and annotated on the strip chart recording. Copies of the strip chart recording and calibration gas certifications will be provided in the final test report.

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METHOD 7E: Oxides of Nitrogen Determination

EPA Method 7E will be used for the continuous measurement of NO_x concentrations in the effluent gas. Method 7E utilizes a chemiluminescent analyzer containing an in-line converter which converts all nitrogen dioxide (NO₂) in the sample to nitric oxide (NO).

The NO_x analyzer will be calibrated using a "zero gas" consisting of oxygen and carbon dioxide blended in nitrogen or ambient air scrubbed free of NO_x. EPA Protocol 1 blends of nitric oxide in nitrogen (NO/N₂) will be used to provide span concentrations of approximately 40 to 60%, and 80 to 100% of the NO_x analyzers' full scale range. All zero and span checks will be recorded and annotated on the strip chart recording. Copies of the strip chart recording and calibration gas certifications will be provided in the final test report.

METHOD 10: Carbon Monoxide Determination

EPA Method 10 will be used for the continuous measurement of CO concentrations in the effluent gas. Method 10 utilizes a non-dispersive infrared analyzer and the same sample system (probe, filter, moisture removal, transfer, pumping, secondary filtration, manifold and calibration gas control module) described in Method 3A. The analyzer output will be recorded by a DAS and strip chart that are operated continuously throughout the test.

The CO analyzer will be calibrated using a "zero gas" consisting of oxygen and carbon dioxide blended in nitrogen (O₂/CO₂/N₂) or ambient air. EPA Protocol 1 blends of carbon monoxide / nitric oxide / nitrogen (CO/NO_x/N₂) will be used to provide span concentrations of approximately 40 to 60%, and 80 to 100% of the CO analyzers' full scale range. All zero and span checks will be recorded and annotated on the chart recording. Copies of the strip chart recording and calibration gas certifications will be provided in the final test report.

METHOD 25A: Volatile Organic Carbon (VOC) Determination (TOC-CH₄)

EPA Method 25A will be used to determine the emissions of volatile organic carbon (VOC) measured as total organic carbon less methane (TOC - CH₄) by flame ionization. Prior to testing a stratification check will be performed to verify that the pollutant concentration is uniformly distributed across the stack. For each test run conducted the end of a "rake" type stainless steel sample probe (described in Method 25) will be placed across the stack flow to provide simultaneous gaseous sampling from three points across the stack.

The sample will be drawn through a probe with a glass or quartz wool filter into a heated Teflon® sample line and through a Teflon head diaphragm pump with a heated recirculation bypass assembly and exhaust. The hydrocarbon analyzer will contain an internal heated sample pump to draw a "hot" and "wet" sample from the heated recirculation bypass at a constant pressure and flow rate. The analyzer output voltage will be recorded by a data acquisition system and a back up strip chart recorder which will be operated continuously throughout the test.

The calibration of the TOC FID analyzer will be verified before and after each test run using three EPA Protocol 1 calibration gas standards. The hydrocarbon analyzer will be calibrated using a "zero gas" consisting of "oxygen-free" nitrogen or scrubbed ambient air. Three blends of propane in nitrogen (C₃H₈/N₂) or propane in air will be used to provide span concentrations in the approximate ranges of 25-35%, 45-55%, and 80-90% of the analyzer's full scale range. All zero, span checks and test run averages will be annotated on the strip chart recording. Copies of the strip chart recording and calibration gas certifications will be provided in the final test report.

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APPARATUS:

Valid Results, Inc. utilizes test equipment designed to meet EPA source test and quality assurance specifications.

CEM Test Van

Valid Results, Incorporated's dry extractive Continuous Emissions Monitoring (CEM) system is contained in an insulated and air conditioned Ford E350 14' Box Van. The CEM system analyzers, data logger and computer are electrically protected by a power line conditioner with true sine-wave voltage output.

CEM Analyzers

<i>Parameter</i>	<i>Method</i>	<i>Analyzer</i>	<i>Technology</i>
O ₂	3A	Siemens Oxymat 5E	Paramagnetic
CO ₂	3A	Siemens Ultramat 5E	Infrared
SO ₂	6C	BOVAR 721ATM	UV Photometric
NO _x	7E	TECO 42H	Chemiluminescence
CO	10	TECO 48	Infrared
VOC	25A	TECO 51-HT	Flame Ionization

Data Acquisition System (DAS)

CEM analyzer output voltage data will be recorded by a Fluke Hydra Data Logger with Trend-Link® and Excel® spreadsheet data export software and a Honeywell DPR3000 strip chart recorder. CEM analyzer zero, calibration and test interval averages will be recorded on the strip chart recording, which will be submitted as a field data sheet in the final test report.

Isokinetic Particulate Tests - Nutech Model 522

316 stainless steel (316 SS) s-type pitot tube, type-K thermocouple, 316 SS, pyrex or quartz nozzle and probe liner, heated four inch glass filter holder containing glass fiber filters on a glass frit, Teflon® sample transfer lines, four Greenburg-Smith® impingers (two containing high performance liquid chromatography (HPLC) grade distilled deionized (DI) water, one empty and one containing indicating silica gel), Teflon® head diaphragm pump with bypass and shut-off valve, Rockwell T110 dry gas meter, critical orifice, dual inclined manometer, type K thermocouples, type K thermocouple readout and solid state temperature controllers. All "sample contacting" surfaces will be rinsed with methylene chloride prior to testing.

DATA:

Copies of all field and analysis data sheets, strip chart recordings, quality assurance checklists and source operating conditions data sheets (recorded by the client) will be included in the final test report.

CALCULATIONS:

All calculations associated with this project will be performed in accordance with the applicable testing and analysis methodology listed in EPA 40CFR60 Chapter I Appendix A. A dimensional analysis summary of all equations used will be included in the final test report. The list of equations and dimensions are included in the attached Tables 1 - 4.

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RESULTS:

Test results will be presented as the arithmetic average of three one hour tests.

PM-10 test results will be presented in concentration units of grains per dry standard cubic feet corrected to seven percent oxygen (grains/dscf @7% O₂). Diluent O₂, CO₂ test results will be presented in concentration units of percent by volume (%/v). Pollutant SO₂, NO_x, CO and VOC test results will be presented in concentration units of parts per million by volume (ppm/v) and emission rate units of pounds per Million British Thermal Units (lbs/MMBtu) of heat input. VOCs will be measured as Propane (C₃H₈) and reported as Total Organic Carbon less Methane (TOC-CH₄).

A comprehensive "draft" copy of the test results will be provided to the Longview Fibre Company within ten (10) days of source test completion. Four bound and one unbound copy of the test report will be submitted to the Longview Fibre Company within twenty-one (21) days of source test completion.

QUALITY ASSURANCE:

VALID RESULTS has developed procedural outline checklists (equipment preparation, field sampling, sample chain of custody, equipment calibration and manual emission rate calculation sheets) for each test method designed to document adherence to the applicable test protocols in accordance with the quality assurance guidelines outlined in document EPA-600/4-77-027b "Quality Assurance Handbook for Air Pollution Measurement Systems, Volume 3". Mr. Prevo completed the EPA Air Pollution Training Institute (APTI) Course #SI:414 "Quality Assurance for Source Emission Measurements" in March of 1993.

CEM analyzers will be calibrated externally before and after every test run by introducing EPA Protocol One calibration gas standards to the front of the sample probe (in front of the filter) while maintaining a constant sample rate and recording each analyzer's response on a data acquisition system, strip chart recorder and field data sheet.

CEM analyzer output voltages will be in alignment with and correspond to the data acquisition system (DAS) and the strip chart recorder settings.

A manual calculation verifying each step of the emission rate calculation for one test run of each of the test methods will be provided in the "final" test report.

SOURCE OPERATIONS:

Facility personnel will be responsible for recording source operating conditions throughout the source test and for providing a source operating conditions report to be included in the final test report.

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Table 1

Volumetric Flow Rate Equations

Equation:

Dimension:

Dry Gas Molecular Weight

$$M_d = 0.44*(\%CO_2) + 0.32*(\%O_2) + 0.28(100 - ((\%CO_2) + (\%O_2)))$$

gm/gm-mole

Stack gas Moisture Content

$$B_{ws} = (V_{wc} + V_{wsg}) / (V_{wc} + V_{wsg} + V_{mstd})$$

decimal fraction

Impinger Volume Gain

$$V_{wc} = 0.04707 * (\text{Final Volume} - \text{Initial Volume})$$

milliliters

Silica Gel Weight Gain

$$V_{wsg} = 0.04715 * (\text{Final Weight} - \text{Initial Weight})$$

grams

Method 4 Corrected Sample Volume

$$V_{m(std)} = (V_m * Y * ((T_{std} + 460) / (T_m + 460)) * (P_m / P_{std}))$$

dscf

Wet Gas Molecular Weight

$$M_s = M_d * (1 - B_{ws}) + 18.0 * B_{ws}$$

gm/gm-mole

Stack Gas Velocity

$$V_s = 85.49 * C_p * \text{SQRT}(\Delta P) * \text{SQRT}((T_s + 460) / ((P_{bar} + (P_{static} / 13.6)) * M_s))$$

feet/second

Corrected Stack Gas Volumetric Flow Rate

$$Q_{s(std)} = 60 * (1 - B_{ws}) * V_s * A_s * ((T_{std} + 460) / (T_s + 460)) * ((P_{bar} + (P_{static} / 13.6)) / P_{std})$$

dscf/m

Stack Area

$$A_s = ((1/4) * (3.1416) * (D_{eq}^2) / (144))$$

square feet

Actual Stack Gas Volumetric Flow Rate

$$Q_{s(actual)} = 60 * V_s * A_s$$

acfm

Table 2

Emission Rate Equations

Equation:

Dimension:

Bias Calibration Correction

$$\text{ppm}_{\text{BC}} = ((\text{ppm}/\text{v one-hour average} - C_o) * C_{\text{ma}} / (C_m - C_o))$$

ppm

Pollutant Correction to Seven Percent Oxygen

$$\text{ppm}_{\text{BC}} @ 7\% \text{ O}_2 = ((\text{ppm}_{\text{BC}}) * (20.9 - 7.0) / (20.9 - \text{O}_2 \text{ STACK}))$$

ppm @ 7% O₂

Gaseous Concentration

$$\text{XX mg/dscm} = ((\text{XX ppm}) * (\text{MW}_{\text{pollutant g/g-mole}}) * (41500) / (1,000,000 \text{ ng/mg}))$$

mg/dscm

Gaseous Concentration

$$\text{XX gm/dscm} = ((\text{XX mg/dscm}) / (1000 \text{ mg/gm}))$$

gm/dscm

Gaseous Concentration

$$\text{XX grains/dscf} = ((\text{XX mg/dscm}) * (0.0154 \text{ grains/mg}) / (35.32 \text{ cubic feet/cubic meter}))$$

gr/dscf

Gaseous Emission Rate

$$\text{XX lb/hr} = ((\text{XX grains/dscf}) * (Q_{\text{s(std)}} \text{ dscf/m}) * (60 \text{ min/hr}) / (7000 \text{ grains/lb}))$$

lb/hr

Gaseous Emission Rate

$$\text{XX tons/year} = ((\text{XX lb/hr}) * (24 \text{ hr/day}) * (365 \text{ days/year}) / (2000 \text{ lb/ton}))$$

tons/year

Gaseous Emission Rate - Heat Input Rate

$$\text{XX lb/MMBtu} = ((\text{XX lb/hr}) / (\text{YY MMBtu/hr}))$$

lb/MMBtu

Gaseous Emission Rate - Fuel Use Rate - EPA Method 19 option

$$\text{XX lb/MMBtu} = ((\text{XX ppm}_{\text{BC}}) * (F_d \text{ dscf/MMBtu}) * (20.9 / (20.9 - \% \text{O}_2 \text{ STACK})))$$

lb/MMBtu

Table 3**Variables**

<u>Variable:</u>	<u>Name:</u>	<u>Dimension:</u>
%CO ₂	stack gas carbon dioxide content (CO ₂ STACK)	percent
%O ₂	stack gas oxygen content (O ₂ STACK)	percent
M _d	stack gas dry molecular weight	gm/gm-mole
V _{wc}	impinger water volume gain (ml)	cubic feet
V _{wsg}	silica gel weight gain (mg)	cubic feet
V _m	Method 4 dry gas meter volume	cubic feet
V _{m(std)}	Method 4 corrected dry gas meter volume	dry standard cubic feet
Y	dry gas meter correction coefficient	dimensionless
T _{std}	standard temperature (68)	degrees Fahrenheit
T _m	measured meter temperature	degrees Fahrenheit
P _{std}	standard pressure (29.92)	inches Mercury
P _m	dry gas meter pressure	inches water
P _{bar}	barometric pressure	inches Mercury
delta H	average critical orifice pressure drop	inches water
B _{ws}	stack gas moisture content	decimal fraction
M _s	wet stack gas molecular weight	gm/gm-mole
V _s	stack gas velocity	feet per second
C _p	pitot tube coefficient	dimensionless
SQRT(Delta P)	The average square root of the pitot tube pressure drop	inches water
T _s	stack gas temperature	degrees Fahrenheit
P _{static}	stack static pressure	inches water
Q _{s(std)}	standard volumetric flow rate	dscf/m
A _s	stack area at sample ports	square feet
π	ratio of circle circumference to diameter	dimensionless
D _{eq}	inside stack diameter at sample ports	inches
Q _{s(actual)}	actual volumetric flow rate	acf/m
MW _(pollutant)	molecular weight of pollutant	gm/gm-mole
C	average reference method value	% or ppm
C _o	average measured bias calibration zero value	% or ppm
C _m	average measured bias calibration value	% or ppm
C _{ma}	actual bias calibration gas value	% or ppm
ppm _v	one hour average pollutant concentration	ppm
ppm _{BC}	pollutant concentration bias calibration correction	ppm _{BC}
ppm _{BC} @7% O ₂	pollutant concentration corrected to 7% oxygen	ppm @7% O ₂
F _d	fuel oil F-factor (9,190 for oil)	dscf/MMBtu
Q _{HEAT INPUT RATE}	fuel use rate and heat capacity (provided by source)	MMBtu/hr

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Table 4
Nomenclature

<u>Nomenclature:</u>	<u>Description:</u>
<i>gm/gm-mole</i>	<i>gram per gram-mole</i>
<i>ft/s</i>	<i>feet per second</i>
<i>dscf/m</i>	<i>dry standard cubic feet per minute</i>
<i>acf/m</i>	<i>actual cubic feet per minute</i>
<i>dscm</i>	<i>dry standard cubic meter</i>
<i>dscf</i>	<i>dry standard cubic feet</i>
<i>gr</i>	<i>grains</i>
<i>mg</i>	<i>milligram</i>
<i>ml</i>	<i>milliliter</i>
<i>%_v</i>	<i>percent by volume</i>
<i>ppm_v</i>	<i>parts per million by volume</i>
<i>ppm_{BC}</i>	<i>bias calibration corrected parts per million</i>
<i>ppm @7% O₂</i>	<i>parts per million corrected to seven percent oxygen</i>
<i>mg/dscm</i>	<i>milligrams per dry standard cubic meter</i>
<i>gm/dscm</i>	<i>grams per dry standard cubic meter</i>
<i>gr/dscf</i>	<i>grains per dry standard cubic foot</i>
<i>lb/hr</i>	<i>pounds per hour</i>
<i>ton/yr</i>	<i>tons per year</i>
<i>lb/MMBtu</i>	<i>pounds per million Btu of heat input</i>
<i>MMBtu/hr</i>	<i>million Btu per hour</i>
<i>dscf/MMBtu</i>	<i>dry standard cubic feet per million Btu</i>
<i>Btu</i>	<i>British thermal unit of heat input</i>